

## CLAIMS

1. A method to model dental restorations, said method comprising:
  - (a) compiling a database of materials for use in preparing a dental restoration;
  - (b) compiling a database of procedures for preparing said dental restoration;
  - (c) determining the geometrical constraints of said dental restoration;
  - (d) determining the aesthetic constraints of said dental restoration; and
  - (e) inputting said geometrical constraints and said aesthetic constraints to a computer to mathematically select from said material database and said procedure database a recipe for producing said dental restoration.
2. A method as defined in Claim 1 wherein said dental restoration comprises a dental prosthesis.
3. A method as defined in Claim 2 wherein said dental prosthesis is selected from the group consisting of a crown, a multiple-element prosthesis such as a bridge, a veneer, an inlay or an onlay.
4. A method as defined in Claim 1 wherein said material database comprises material selections for use in one or more of a substructure, dentin, enamel, masks or stains.
5. A method as defined in Claim 1 wherein said procedure database comprises one or more of a milling, plasma fusion, rapid-prototyping, layering and fusion of porcelain, polymerization of resins or composites.

6. A method as defined in Claim 1 wherein said geometrical constraints are obtained from a theoretical teeth library, from a CAD system or both.
7. A method as defined in Claim 6 wherein said CAD system obtains dental arcade shape information from a shape measuring device that uses optical means or a tactile system.
8. A method as defined in Claim 1 wherein said aesthetic constraints are obtained from light reflection measurements.
9. A method as defined in Claim 8 wherein said light reflection measurements comprises illuminating the teeth or dental restorations in a controlled way and measuring the light reflected from different regions of the teeth or dental restoration.
10. A method as defined in Claim 9 wherein a color camera is used for measuring the reflected light.
11. A method as defined in Claim 1 wherein said recipe for producing said dental restoration comprises a layer-by-layer instruction wherein each layer is characterized by its shape, thickness and material composition.
12. A method as defined in Claim 1 wherein said computer is further input with constraints determined by a dentist and/or dental technician.
13. A method as defined in Claim 12 wherein said dentist and/or dental technician constraints comprise limitations on the choice of material, complexity of the procedure and/or coarseness of the recipe.
14. A method as defined in Claim 11 wherein each layer may be divided into sublayers.

15. A method as defined in Claim 13 wherein said recipe coarseness is constrained by defining the minimal voxel size and/or limiting the number of sublayers.
16. A method as defined in Claim 1 wherein said recipe is used as input to a machine for producing said dental restoration.
17. A method as defined in Claim 16 wherein said machine comprises a milling machine, a plasma fusion machine or a rapid prototyping system.
18. A method as defined in Claim 16 wherein said machine produces only part of said dental restoration and a person completes said recipe.
19. A method as defined in Claim 16 further comprising using said produced dental restoration for validating said method.
20. A method as defined in Claim 16 further comprising using said produced dental restoration for refining said method.
21. A method as defined in Claim 1 wherein recipe selection comprises defining dental restoration and dividing said dental restoration volume into voxels and parameterizing each said voxel with one or more of absorption, diffusion, reflection, refraction and transmittance coefficients based on the wavelength of light entering said voxel.
22. A method as defined in Claim 21 wherein said wavelength parameters are constrained to the human visual spectrum.
23. A method for designing dental restoration with predetermined aesthetic qualities, said method comprising:
  - (a) compiling a database of criteria for use in designing an aesthetic dental restoration;

- (b) compiling a database of procedures for preparing said dental restoration;
- (c) determining the geometrical constraints of said dental restoration;
- (d) determining the aesthetic constraints of said dental restoration; and
- (e) inputting said geometrical constraints and said aesthetic constraints to a computer to mathematically select from said criteria database and said procedure database a feasible design for said dental restoration.

24. A method as defined in Claim 23 further comprising:

- (i) compiling a database of materials;
- (ii) modeling dental restorations with said selected materials; and
- (iii) inputting said geometrical constraints and said aesthetic constraints to a computer to mathematically select from said criteria database, said procedure database and said material database a feasible design for said dental restoration.

25. A method as defined in Claim 24 further comprising (f) emulating said selected dental procedure with said selected material on said computer to image process the most likely outcome of the dental restoration.

26. A method as defined in Claim 24 wherein said dental restoration modeling includes the interaction of a light with said selected material.

27. A method as defined in Claim 26 wherein said interaction with a light with said selected material is computed for a sampling of wavelengths characteristic of human visual perception.

28. A method as defined in Claim 23 further comprising comparing said predicted dental restoration image with the dental restoration to determine differences in morphology and/or symmetry.

29. A method as defined in Claim 28 wherein said differences are input to said computer to build a database.

30. A method as defined in Claim 28 wherein said selected dental procedure comprises a series of steps.

31. A method as defined in Claim 30 wherein said differences are measured after each step in said selected dental restoration procedure.

32. A method as defined in Claim 31 wherein said selected dental procedure comprises tooth whitening.

33. A method as defined in Claim 32 wherein the appearance and shape of the tooth is measured before and after each tooth whitening application step.

34. A method for producing an aesthetic prosthesis, said method comprising:

- (a) acquiring quantitative data on shape and appearance;
- (b) processing said quantitative data to determine the desired result;
- (c) further processing said quantitative data and the desired result to determine a method for achieving said desired result;
- (d) manufacturing the underlying structure of said prosthesis; and
- (e) finalizing said prosthetic work.

35. A method as defined in Claim 34 wherein said shape quantitative data comprises the digital measurement of teeth.

36. A method as defined in Claim 35 wherein said shape quantitative data comprises is obtained by using sensors to acquire digital shape information of patient's teeth directly in the patient's mouth.

37. A method as defined in Claim 35 wherein said shape quantitative data comprises taking an imprint of a patient's teeth; and using sensor's to acquire digital shape information directly from said imprint or from a model prepared based on said imprint.

38. A method as defined in Claim 34 wherein said appearance data comprises the digital measurement of the light reflection of the teeth.

39. A method as defined in Claim 34 wherein said shape quantitative data and/or aesthetic quantitative data are communicated to a design center node.

40. A method as defined in Claim 39 wherein said communication occurs through a computer network.

41. A method as defined in Claim 40 wherein said computer network comprises the Internet.

42. A method as defined in Claim 34 wherein said shape and aesthetic quantitative data are processed using computer aided design tool to determine the shape and appearance for said prosthesis.

43. A method as defined in Claim 39 wherein said shape and aesthetic quantitative data are received by a computer aided design tool from said design center node to determine the shape and appearance for said prosthesis.

44. A method as defined in Claim 42 wherein said shape and appearance for said prosthesis is communicated to a calculation center node.

45. A method as defined in Claim 44 wherein said communication occurs through a computer network.

46. A method as defined in Claim 45 wherein said computer network comprises the Internet.

47. A method as defined in Claim 34 wherein said desired shape and appearance for said prosthesis information is further processed to determine a method for achieving said desired result using computer aid manufacturing tools to determine the manufacturing process for manufacturing the underlying structure of the prosthesis and the steps required for finishing the prosthesis.

48. A method as defined in Claim 47 wherein said manufacturing process is communicated to a production center node.

49. A method as defined in Claim 48 wherein said communication occurs through a computer network.

50. A method as defined in Claim 49 wherein said computer network comprises the Internet.

51. A method as defined in Claim 34 wherein said manufacturing comprises milling, rapid prototyping or deposition on model to produce said underlying structure for said prosthesis.

52. A method as defined in Claim 51 wherein said underlying structure for said prosthesis and finishing instructions are forwarded to a dental laboratory node.

53. A method as defined in Claim 39 wherein said communications to said design center node, calculation center node, production center node, and dental laboratory node are made through a communication center.

54. A method as defined in Claim 53 wherein said communication center uses the data from said communications to develop a database of clinical cases.

55. A method for communicating information related to dentistry comprising:
- (a) collecting information regarding an dentistry procedure;
  - (b) communicating said information to a central source via a computer network for analysis.
56. A method as defined in Claim 55 wherein said collected information comprises transactional information, scientific information regarding natural teeth, marketing information and combinations thereof.
57. A method as defined in Claim 56 wherein said scientific information regarding natural teeth comprises shape measurements.
58. A method as defined in Claim 56 wherein a tooth appearance measurement device is used to collect said information.
59. A method as defined in Claim 56 wherein (i) a practitioner takes measurements and/or images of a patient's teeth using a tooth appearance measurement device; (ii) said device includes software for maintaining an historic database of said measurements and/or images; (iii) said device communicates said measurements and/or images to a central server; (iv) the central server collates and integrates the received measurements and/or images with accounting information regarding the practitioner; and (v) the central server generates a bill to the practitioner or directly debits the practitioner's account.
60. A method as defined in Claim 58 wherein said information from the tooth appearance measurement device is communicated to a web site via the internet.
61. A method as defined in Claim 60 wherein the information received by said web site is analyzed to collect shade guide information to design a translucency scale for tooth restoration materials.



62. A method as defined in Claim 61 wherein the information received by said web site is analyzed to determine the range, distribution and granularity of colors for tooth restoration material systems.

63. A method as defined in Claim 56 wherein said transactional and marketing information is analyzed to obtain information regarding buying practices, services offered and/or internal procedures of dentists and dental laboratories.

64. A method as defined in Claim 60 wherein the information received by said web site is analyzed to determine a recipe for fabricating a dental restoration.

65. A method as defined in Claim 64 further comprising collecting said recipes in a database to develop an expert resin recipe database and/or an expert ceramic recipe database.